Pestic. Sci. 1997, **49**, 395–397

Extended Summaries
42nd Hungarian Plant Protection Days Meeting

The following are extended summaries based on papers presented at the 42nd Hungarian Plant Protection Days Meeting, organised by the Hungarian Agricultural Society, the Hungarian Academy of Sciences, the Hungarian Ministry of Agriculture and the Plant and Soil Protection and Soil Conservation Station of Budapest and held in Budapest, Hungary on 27/28 February, 1996. They are entirely the responsibility of the authors and do not necessarily reflect the views of the Editorial Board of Pesticide Science.

Factors Affecting the Phytotoxicity of the Herbicide Acetochlor to Monocotyledonous and Dicotyledonous Weeds

István Jablonkai, Ágnes Hulesch & István C. Barta

Department of Pesticide Research, Central Research Institute for Chemistry, Hungarian Academy of Sciences, PO Box 17, H-1525 Budapest, Hungary

Acetochlor (2-chloro-*N*-ethoxymethyl-6′-ethylacet-*o*-toluidide) is a herbicide used effectively in Hungarian agriculture for controlling monocotyledonous (monocot) and, to a lesser extent, dicotyledonous (dicot) weeds in maize (*Zea mays* L.). It has been shown that maize, wheat, and soybean plants detoxify acetochlor to water-soluble metabolites as a result of conjugation with glutathione (GSH).[1,2] Endogeneous levels of GSH and glutathione *S*-transferase (GST) enzymes in these plants were found to be the major factors in acetochlor detoxication and selectivity.[3] By contrast, no information on the fate of acetochlor in weeds has been available. Also, the biochemical basis for the differential level of response of monocot and dicot weeds to acetochlor treatment has not been established.

The objective of this study was to review factors such as uptake, translocation, metabolism, GSH levels and GST activities which might affect selectivity of acetochlor in monocot and dicot weeds. Selective phytotoxicity of acetochlor at pre-emergent application ($0{\cdot}16$ kg ha^{-1}) was studied with selected monocot weeds such as wild oat (*Avena fatua* L.), cheatgrass (*Bromus secalinus* L.), barnyardgrass (*Echinochloa crus-galli* L.), and such dicot weeds as velvetleaf (*Abutilon theophrasti* L.), redroot pigweed (*Amaranthus retroflexus* L.), common cocklebur (*Xanthium strumarium* L.) and with maize (Pannonia SC hybrid). Uptake, translocation and metabolism of the root-applied herbicide were studied in nutrient solution at 24-h exposure with 12-day-old weed and five-day-old maize seedlings using [*carbonyl*-^{14}C]acetochlor (6 μM, 37 MBq mmol^{-1}) as has been described previously.[4] Six-day-old etiolated weed and four-day-old etiolated maize seedlings were used to determine GSH levels.[3] GST activities were characterized with crude enzyme extracts of the same-aged etiolated seedlings using [*carbonyl*-^{14}C]acetochlor and 1-chloro-2,4-dinitrobenzene (CDNB) substrates.[3] Whole seedlings were used for determination of GSH and GST levels.

In growth-response studies (Table 1) barnyardgrass was the most sensitive monocot. Wild oat was moderately sensitive, while cheatgrass proved to be the least sensitive species to acetochlor. Among dicot weeds, velvetleaf and cocklebur were much less sensitive than redroot pigweed. Dicot seedlings absorbed more acetochlor through the roots than monocot seedlings of the same age; however, velvetleaf and cocklebur, which were the least sensitive weeds to acetochlor, took up far less than maize seedlings. In all weed species the movement of root-absorbed radioactivity to shoots took place more readily than in maize. Rates of translocation were similar in monocot and dicot seedlings. Metabolism of acetochlor was characterized as the percentage of the absorbed radioactivity transformed to a water-soluble form and, regardless of their susceptibility to

Pestic. Sci. 0031-613X/97/$17.50

TABLE 1

Growth inhibition characteristics, uptake, translocation and metabolism of acetochlor in monocot and dicot weeds and maize as well as GSH levels of these plants[a]

Plant species	*Growth inhibition*[b] (*% of control*)	*Uptake*[c] (*ng per seedling*)	*Translocation*[d] (*% of* ^{14}C *in shoots*)	*Metabolism*[d] (*% of* ^{14}C *in water-soluble form*)	*GSH content* (μg *per seedling*)
A. fatua	17 (±3)	35 (±5)	28 (±4)	73 (±6)	4·8 (±0·7)
B. secalinus	45 (±7)	20 (±4)	29 (±5)	89 (±5)	1·4 (±0·3)
E. crus-galli	5 (±2)	10 (±3)	34 (±5)	76 (±7)	0·8 (±0·2)
A. theophrasti	74 (±5)	1 080 (±145)	32 (±4)	92 (±3)	4·7 (±0·7)
A. retroflexus	15 (±3)	54 (±7)	28 (±5)	92 (±4)	0·2 (±0·1)
X. strumarian	87 (±6)	2040 (±230)	23 (±4)	47 (±8)	53·8 (±6·9)
Maize	107 (±6)	25000 (±1480)	5 (±2)	96 (±2)	61·5 (±4·8)

[a] Data represent the means of two experiments with three replicates per experiment; standard deviations are given in parentheses.
[b] Calculation based on shoot length of plants 14 days after treatment with 0·16 kg ha^{-1} acetochlor.
[c] From 5 or 100 ml [*carbonyl*-^{14}C]acetochlor solution (6 μM) for weed and maize seedlings, respectively.
[d] Calculation based on radioactivity absorbed by seedlings.

acetochlor, all plants except cocklebur metabolized the major part of the absorbed herbicide to water-soluble metabolite(s) during 24-h treatment. Cocklebur was an exception because only 47% of the absorbed radioactivity was detected in water-soluble form. No direct correlation between GSH levels and acetochlor sensitivity of weeds was found, but there was a great difference in GSH level of cocklebur and velvetleaf, in terms of μg per whole seedling, despite both having similar acetochlor susceptibility. GST activities characterized using either CDNB or acetochlor substrates were not correlated with acetochlor susceptibility of these weed species (Fig. 1). Using CDNB substrate, GSTs from monocot seedlings exhibited much higher activities than those from dicot seedlings; GST(CDNB) activity detected in wild oat even exceeded that in maize. With [^{14}C]acetochlor substrate, GST activities were in the same range from both monocot and dicot seedlings except for velvetleaf. Extractable GSTs from velvetleaf did not show specificity for acetochlor even though velvetleaf converted 92% of acetochlor absorbed to water-soluble metabolite(s). Nevertheless, GST(acetochlor) activities in all weeds examined were less expressed than in maize. Also, enzyme activities cannot be correlated with susceptibilities toward acetochlor.

Our results demonstrate that the tolerance of maize to acetochlor is strongly related to its higher level of GSH and GST, which are the two major components of

Fig. 1. Glutathione *S*-transferase activities of monocot and dicot weeds and maize. GST(CDNB) and GST(acetochlor) are glutathione *S*-transferase activities measured with CDNB and acetochlor substrates, respectively. Abbreviations: AVEFA: *A. fatua*, BROSE: *B. secalinus*, ECCHR: *E. crus-galli*, ABUTH: *A. theophrasti*, AMARE: *A. retroflexus*, XANST: *X. strumarium.* Values are means of two experiments with three replicates per experiment. Bar = SD.

the glutathione conjugation system, as compared to those in weeds. In order to comprehend differential responses of monocot and dicot weeds to acetochlor, further studies on the chemical nature of the metabolities are needed.

REFERENCES

1. Jablonkai, I. & Dutka, F., Metabolism of acetochlor herbicide in tolerant and sensitive plant species. *J. Radioanal. Nucl. Chem. Letters*, **94** (1985) 271–80.
2. Breaux, E. J., Identification of the initial metabolities of acetochlor in corn and soybean seedlings. *J. Agric. Food Chem.*, **34** (1986) 884–8.
3. Jablonkai, I. Hatzios, K. K., Role of glutathione and glutathione *S*-transferase in the selectivity of acetochlor in maize and wheat. *Pestic. Biochem. Physiol.*, **41** (1991) 221–31.
4. Jablonkai, I., Basis for differential chemical selectivity of MG-191 safener against acetochlor and EPTC injury to maize. *Z. Naturforsch.*, **46c** (1991) 836–45.